

ONTARIO AGRICULTURAL COLLEGE AND EXPERIMENTAL FARM.

THE CULTIVATION OF SUGAR BEETS.

By A. E. SHUTTLEWORTH, B.A.Sc., Ph.D., PROFESSOR OF CHEMISTRY.

INTRODUCTION.

Sugar beets for cattle feed can be grown probably in any part of Ontario; but owing to favorable climatic conditions, they can be grown for the production of sugar more profitably in certain portions or sections than in others. Experience in counties where the sugar beet is extensively grown shows that it attains its greatest perfection where the temperature for the months of May, June, and July has a mean of 70° F.

A line running from Sarnia in a southeasterly direction to St. Thomas and then curving gradually in a northeasterly direction through the counties of Norfolk and Haldimand to the city of Hamilton would locate the northern boundary of the United States theoretical beet-sugar belt passing through Ontario. The section of Ontario to the south of this line, comprising Essex, Kent, Bothwell, Elgin, Welland, Lincoln and the southern portions of Lambton, Middlesex, Norfolk, Haldimand and Wentworth, possesses favorable climatic, and, for the most part, soil conditions for the highest development of the sugar beet.

It is not to be understood however, that there are no other sections in Ontario where sugar beets can be grown for sugar production. Temperature and length of season both north and east are more or less influenced by the lakes; consequently, in sections where land can be cultivated for planting by the 1st of May and where favorable beet harvesting weather can be depended upon through October and the early part of November, beets may be produced as successfully as within the above named section.

To grow sugar beets with a high content of sugar and a paying tonnage, which are requisites of the beet sugar industry, requires a high degree of agricultural skill. It is indeed a great mistake to suppose that because a farmer may be able to grow sugar beets for feed, he can also grow them for sugar production. The former means bulk, while the latter means quality and bulk. To produce quality, i.e., a high content of sugar, requires knowledge, experience, and skill. By a very little difference in the soil, in the cultivation, in the kinds

and the quantity of manure, in the thinning, &c., a very great difference in the sugar content of the beets may result. The usual methods of cultivation and manuring practised to produce a big crop of turnips, potatoes, &c., applied to the cultivation of sugar beets would produce an unprofitable crop for factory purposes. In every country where beet sugar industries are established, is has required from two to three years' practice before the farmers have been able to grow beets containing satisfactory percentages of sugar.

Past analyses of sugar beets grown in Ontario have shown that fully one-third of each year's crop contains less than 12 per cent. of sugar, a percentage too low for factory use. It would indeed be a serious matter to both the farmer and the factory should one-third of the total crop grown for a factory contain only 12 per cent. or less than 12 per cent. of sugar. To avoid such a misfortune small plots of sugar beets should be grown according to definite instructions where a factory is likely to be established. Such an experiment would be an object lesson not alone to those growing the beets but more or less to all farmers in the neighborhood, and by the analyses of the beets valuable data regarding the fertility and the requirements of the soil of different farms and sections would be collected. In this way the farmers would learn quickly and inexpensively to produce crops of beets of high tonnage and rich in sugar.

Restitution to the soil of the constituents removed has to be considered in good farming more or less for all crops, and especially for any root crop. The impression prevails that sugar beets are particularly hard upon soil and will in time impoverish land. This is not necessarily true with sugar beets any more than with other root crops. Twelve tons of sugar beets, not including tops, removed from the soil 79.2 lbs. potash, 19.2 lbs. phosphoric acid, and 38.4 lbs. nitrogen, while an equal weight of turnips removes 48, 14.4 and 52.8 lbs. respectively of potash, phosphoric acid, and nitrogen. The comparison does not, except in the constituent potash, show that beets are more exhaustive than turnips. The tops of the twelve tons of beets contain 156 lbs. potash, 31.2 lbs. phosphoric acid, and 93.6 lbs. of nitrogen. This fact, however, is true of all root crops, viz., that the tops contain large quantities of ash constituents. A strictly scientific method of cultivation considers the available fertility already in the soil and supplies, less than in the soil, all that the crop requires. In the cultivation of sugar for factory purposes, since a high content of sugar as well as a high tonnage is required, particular attention must be given to the form in which the manure is applied and to the relative quantities of the several ash constituents. An unproportional amount of nitrogen, for example, will prevent the formation of sugar, yielding, it may be, a high tonnage, but an unprofitable crop for sugar production.

In Germany, where the sugar beet is a staple crop, it occupies a position in the crop rotations between fall rye or winter wheat and a spring cereal crop, usually wheat or barley. By many large farmers the sugar beet is the money producing crop, while the other crops and the live stock are regarded as auxiliaries to it. A sugar beet farmer is also a dairy farmer who keeps from 50 to 100 milch cows per 600 to 800 acres of land. The sugar beet pulp, especially when fed along with sugar beet tops, is an excellent food for dairy stock, and the large quantities of straw grown on sugar beet farms used as fodder and as bedding, furnish manure which is applied to the land for the winter rye or wheat which preceded sugar beets. In a word, live stock and grain growing are usually combined with and auxiliary to sugar beet cultivation.

The kind of soil is also a factor in the cultivation. Almost all sugar beets may be grown on any soil. Whatever kind of soil should the sugar beet be best in a warm and moist soil. It requires under also late in the season to grow and to be content. A soil which is not cultivated properly

In proportion to the reduced growth but in proportion to the available, the then, can be formed and quality important constituents of acid, potash and

Phosphoric acid quickens germination lessening the increases the high and content

Nitrogen inorganic, as but by the increase especially so, the nitrogen.

Although to the exact effect apply, it is known that the amount of sugar

It is only any manurial their can be made will determine the constituents of the beets. A manure that affects the quality of the form in which the important quantities of manure required

SOIL.

The kind of soil suitable for sugar beets is of less importance than cultivation. Almost any soil by proper cultivation in a suitable climate will grow sugar beets. This crop does not require a particular kind of soil. Good crops may be grown upon clay, loam, sand, or even prairie soil with proper cultivation. Whatever kind the soil may be it must not, however, be wet nor cold, neither should the subsoil be hard and impervious to air and moisture. The beet does best in a warm moist soil having an open subsoil which is also naturally warm and moist. Clay soils, which have a high retentive power for moisture, usually require underdraining. To be able to get upon the land early in the spring and also late in the fall, is of great importance, for the beet requires sufficient time to grow and mature in order to produce both high tonnage and large sugar content. A soil capable of producing a good crop of potatoes will yield with proper cultivation paying crops of sugar beets.

MANURE.

In proportion to a deficiency of nourishment in the soil and a consequent reduced growth, the quality of the sugar beet for factory purposes deteriorates; but in proportion to the degree to which proper and sufficient nourishment is available, the quantity and quality of the sugar beet improve. The best results, then, can be produced only when there are available to the plant in the right form and quantity in the presence of other required conditions, the four most important constituents in the nourishment of beets, viz, nitrogen, phosphoric acid, potash and lime.

Phosphoric acid in the form of water soluble, as in superphosphates, quickens germination and effects a rapid growth of the young plant, thereby lessening the probability of injury by insects and disease. Phosphoric acid also increases the yield and hastens early maturity, making the sugar percentage high and consequently the crop of increased value to a factory.

Nitrogen both organic, as in decaying animal and vegetable matter, and inorganic, as in nitrate of soda, sulphate of ammonia, clearly increases the yield; but by the improper use of nitrogen the quality of the beet is distinctly injured, especially so, when a corresponding amount of phosphoric acid is not used with the nitrogen.

Although there are no definite conclusions from experiments conducted as to the exact effects of potash and as to the most suitable form of potash salt to apply, it is known to be an essential and important constituent in the nourishment of sugar beets.

It is only when all the other required elements of fertility are present that any manurial constituent or combination of constituents has any value; therefore, there can be no normal manure for sugar beets. An actual experiment alone will determine for a particular location or soil the constituent or combination of constituents that may be used to the best advantage in the cultivation of sugar beets. A manure calculated to give the best results upon one soil, may depreciate the quality of the beets on other soil. What a soil already contains and the form in which its elements essential to the normal growth of the beet exist, are important questions which require answering before the kind and quantity of manure required by a particular soil can be prescribed.

In no case is it a safe practice to apply farm-yard manure to sugar beets in the spring or early summer. If the early summer be dry, the manure will not decompose; consequently the soil will remain too loose and open and the young plants will suffer from drouth. A wet period may follow the dry spell, which circumstance, owing to the late fermentation of the manure, develops leaf growth and produces a heavy crop but of inferior quality. The later the second growth occurs the more the percentage of sugar is lowered. Unfermented manure further affords favorable conditions for the operation of insects that are enemies



FIG. 1.—Correct position of a mature beet in the soil.

of the sugar beet, makes surface cultivation difficult, produces rooty beets, and predisposes the plants to disease. If a direct application of farm-yard manure, is to be made, early in the previous fall is the proper time, but even applied at that time the manure should be more or less decomposed. It is better, however, to apply farm-yard manure to a preceding crop. The residue of this manure, supplemented by purchased fertilizers, will furnish the best fertility for the beets.

THE POSITION OF SUGAR BEETS IN A ROTATION.

They should follow a crop to which farm-yard manure has been applied, and should be followed by wheat, barley or oats. It must be remembered that

sugar beets
tion:

1. Hay
2. Win
3. Suga
4. Sprin

Fig 1, s
rates the gre
soil is of the
high percent
develops late
which tend t

If the b
ing the stubb
causing the v

cross-plow to
plow (Fig. 2)
the land, thur
expansion and
potatoes or fo
ground should
the purpose o
part, however
above describ
naturally free

In case i
preceding sug

sugar beets should never follow oats. The following is a suitable rotation:

1. Hay.
2. Winter wheat, potatoes, or fodder corn.
3. Sugar beets.
4. Spring wheat, barley, or oats, seeded.

FALL CULTIVATION.

Fig 1, showing the proper position of the beet at maturity in the soil, indicates the great depth to which the taproot penetrates. This penetration of the soil is of the greatest importance in securing a steady growth of plant and a high percentage of sugar. Meeting impervious subsoil deflects the taproot, develops lateral roots, and lifts the beet more or less out of the ground, all of which tend to lessen the percentage of sugar.

If the beets follow fall wheat, the land may be plowed shallow, just covering the stubbles, as early after the wheat is harvested as possible and harrowed, causing the vegetable matter to decay and seeds to germinate. Late in autumn,

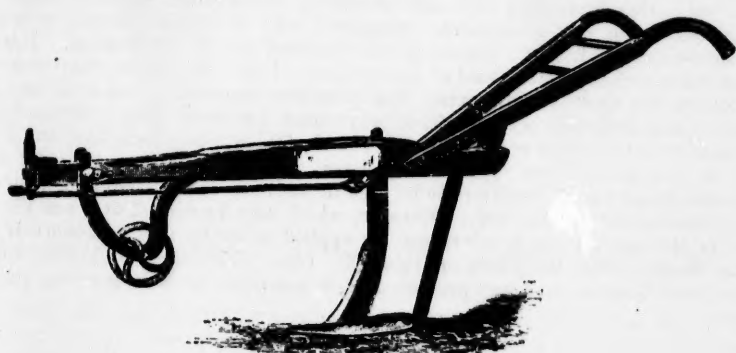


FIG. 2.—Subsoil plow.

cross-plow to a depth of nine inches, following in each furrow with a subsoil plow (Fig. 2), loosening (not turning up) the soil several inches deeper. Leave the land, thus plowed and loosened, to the winter frost, which through alternate expansion and contraction, becomes disintegrated and mellowed. But in case potatoes or fodder corn precede the beets, early autumn cultivation of the potato ground should not be necessary, while that of the corn land may be modified for the purpose of disposing of the corn roots. Late deep plowing is an essential part, however, of fall cultivation for sugar beets on any soil; but subsoiling, as above described, may be omitted in exceptional instances where the subsoil is naturally free and open.

In case it has not been practicable to apply farm-yard manure to the crop preceding sugar beets, then the manure should be drawn out upon the stubble

land and just covered by the early autumn shallow plowing which is mentioned above.

SPRING CULTIVATION AND PLANTING.

Plant as early as climate and soil will allow. In that area, previously mentioned, where sugar beets may be expected to do well, plant not later than May 1st. Early planted beets, as experience in other countries has shown, uniformly give both a greater yield and a higher content of sugar than those which are planted later.

Spring cultivation for planting must be shallow, the object being to prepare a seed-bed whose soil is reduced to the highest degree of tilth, resembling the surface soil of a well prepared onion bed. The exact method of working the land to attain this object will vary in different locations and soils as soils themselves and weather vary. For every soil, however, loosening the surface to a depth of three inches is an essential operation, after which, by the proper use at the right time, of the roller and harrow, a seed-bed, which is mellow, firm, moist and warm, can with little difficulty be prepared. The seed should be planted upon the same day, or as early after as possible, as the final preparation of the seed bed. Before planting and while preparing the seed-bed, commercial fertilizers containing the constituents phosphoric acid and potash, should be sown broadcast and worked into the soil of the seed-bed in its preparation. Hardwood ashes and superphosphate of lime (water soluble phosphate) may be used to furnish the above constituents. The quantities required, since soils vary in fertility and fertilizers in composition, may differ for every soil. Fifteen tons of beets with their tops require 300 lbs. potash, 60 lbs. phosphoric acid, and 155 lbs. of nitrogen. These figures may form the best basis for calculating the required quantities of fertilizers to be used in addition to the manure or residue of manure already in the soil. Nitrogen, which may be needed over and above that in the manure, can to advantage be applied in the form of a soluble salt as a top dressing after the plants are thinned. Lime, which may be obtained from sugar beet factories as a bye-product free, is essential in soils growing sugar beets.

SEED.

The choice of seed is a matter of very great importance. Under no consideration should an inferior variety or quality of seed be sown. Owing to the many good varieties of sugar beets, arising chiefly from selection and culture, it is not easy to name all. The Vilmorin Improved (Fig. 3) and the Kleinwanzlebener (Fig. 4) have been the most widely grown in America.

When the soil of the seed-bed has been reduced to a finely divided condition, it should be compressed by rolling, and upon the same day the seeds may be planted to a depth of one inch. Planting, therefore, is *upon the flat*, done either by hand or by drill at the rate of 16 pounds of seed per acre.

The best results in root and sugar content are obtained by a distance of 21 inches between the drills, and seven inches between the plants in the drill. At these distances, the ground becomes completely covered with the foliage, a condition which is very essential to a paying percentage of sugar. After planting, the land should be harrowed once lengthwise with the planting

with light s
In from ten
minated.

As soon
soil between
moisture, to
most rapid



Fig. 3.—White

by hand, but
young plants
therefore, a s
disturbed by

After the
development
finished as so
but the hands
young selected

During the
arrived for a s
in the first cul

with light seed harrows, for the purpose, chiefly, of preserving the soil moisture. In from ten to fourteen days, with favorable weather, the plants will have germinated.

CULTIVATION OF BEETS BEFORE THINNING.

As soon as the plants can be traced in the row, surface cultivation of the soil between the drills should be commenced, to clean the land and preserve moisture, to admit air more freely into the soil, and in every way to hasten the most rapid growth of the young plants. This cultivation may be accomplished



FIG. 3.—White Improved Vilmorin Sugar Beet.



FIG. 4.—Kleinwanzlebener Sugar Beet.

by hand, but more quickly by a horse hoe. It should be remembered that the young plants are easily injured, either by a covering of earth or by being loosened; therefore, a strip of 2 inches on each side of the plants in the drill should not be disturbed by this early cultivation.

THINNING.

After the first cultivation, the young plants grow rapidly when, upon the development of the 3rd or 4th leaf, thinning must be commenced, and should be finished as soon after as possible. Thinning is done chiefly with a narrow hoe, but the hands must be also freely used in singling out for the reason that the young selected plants, unlike turnips, must not be roughly handled.

CULTIVATION AFTER THINNING.

During thinning, the beet will have grown considerably, and the time having arrived for a second cultivation, the hand or horse hoe may be run deeper than in the first cultivation, in order to open thoroughly and loosen the soil for the

free admission of air. A second hand hoeing soon after finishing the first thinning is advisable, for the reason that two or more plants growing together injure one another both in size and quality. It has also the advantage of cleaning and loosening the ground in the drills between the plants. Even a third and a fourth horse hoeing may be done, depending, of course, upon circumstances. Every cultivation promotes growth, improving the chances for a profitable crop, but must never be done when the ground is wet.

HARVESTING.

The right time for harvesting varies with circumstances. The later it is delayed the better, provided sufficient fine weather remains to accomplish the work, and provided the beets are not in danger of a second growth. Both wet weather and freezing temperatures are undesirable; consequently, if the beets have ripened, harvesting may begin any time in October. Yellowish green color of leaf, drooping and dying leaves are indications of ripened beets. Harvesting beets is not difficult. The beets are loosened from the ground either with a spade-like instrument or by a machine called a beet harvester. Topping is done with a large knife held in the hand. The operation consists in removing the whole of that portion of the beet to which the stem of the leaves have been attached. The topped beets are thrown into piles or rows and covered with the tops, which protect them from sun and frost till delivered at the factory.